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CLAIMS

What is claimed is:

Sub B1  
1. A filtering system for filtering working fluid from a machine comprising a filter having a filter media element for filtering said working fluid, said filter having a first inlet receiving working fluid from said machine, said filter having a first outlet returning working fluid to said machine, said filter having a second inlet receiving a cleaning fluid from a source of cleaning fluid, said filter having a second outlet exhausting said cleaning fluid, said filter media element having a clean side communicating with said first outlet and said second inlet, said filter media element having a dirty side communicating with said first inlet and said second outlet, said filter having a first flowpath therethrough from said first inlet through said filter media element in one direction to said first outlet, said filter having a second flowpath therethrough from said second inlet through said filter media element in the opposite direction to said second outlet, said first and second flowpaths having common but opposite direction portions through said filter media element, said filter having a filtering mode of operation with said second inlet closed and said second outlet closed and filtering fluid flow therethrough along said first flowpath, said filter having a backwash mode of operation with said second inlet open and said second outlet open and said cleaning fluid flowing therethrough along said second flowpath and backwashing contaminant-laden working fluid from said dirty side of said filter media element to said second outlet, a contaminant separator having an inlet connected to said second outlet of said filter and receiving and separating contaminant from said contaminant-laden working fluid.

2. The invention according to claim 1 wherein said contaminant separator also stores said contaminant, said contaminant separator having an outlet discharging working fluid after separation of contaminant.

3. The invention according to claim 2 wherein said filtering system comprises a circulation system circulating working fluid to said machine, and wherein said outlet of said contaminant separator discharges working fluid to said circulation system.

4. The invention according to claim 3 wherein said circulation system comprises a sump containing working fluid for said machine, and wherein said outlet of said contaminant separator discharges working fluid to said sump.

5. The invention according to claim 1 wherein said contaminant separator comprises a batch processor operative during said backwash mode of said filter and receiving said contaminant-laden working fluid from said second outlet of said filter and separating and storing contaminants, and passing working fluid.

6. The invention according to claim 5 wherein said filter is a continuous flow filter in said filtering mode, and said batch processor is a non-continuous flow centrifuge having a rotor driven during said backwash mode of said filter to separate said contaminants, said rotor being non-driven during said filtering mode of said filter.

7. The invention according to claim 1 wherein said contaminant separator comprises a centrifuge having a rotor separating contaminant from working fluid, and a storage container storing said contaminant.

8. The invention according to claim 7 wherein said rotor of said centrifuge is driven to rotate by a motive force, and wherein said motive force and said cleaning fluid are each provided by pressurized air.

9. The invention according to claim 8 wherein said source of cleaning fluid comprises a source of compressed air, and wherein the same said source of compressed air supplies both said motive force for said rotor and said cleaning fluid for said filter.

10. The invention according to claim 7 wherein said storage container comprises a second filter media element reducing fluid turbulence particularly during rotor speed gradients at start-up and trapping contaminant particles and reducing particle re-entrainment during said rotor speed gradients.

11. The invention according to claim 10 wherein said second filter media element comprises a matrix of filter material of at least 75% void volume.

12. The invention according to claim 11 wherein said void volume is at least 95%.

13. The invention according to claim 7 wherein said centrifuge has a minimum capacity equal to the capacity of said stored contaminant plus the capacity of said filter.

14. The invention according to claim 13 wherein said rotor includes an annular chamber providing said storage container.

15. The invention according to claim 7 wherein said rotor of said centrifuge is driven to rotate by a motive force, said motive force and said cleaning fluid are each provided by pressurized air, said source of cleaning fluid comprises a source of compressed air, said source of compressed air supplies both said motive force for said rotor and said cleaning fluid for said filter, and comprising a first valve controlling the supply of pressurized air from said source of compressed air to said second inlet of said filter, and a second valve controlling the supply of pressurized air from said source of compressed air to said rotor of said centrifuge, said first and second valves operating such that said rotor begins spinning prior to introduction of contaminant-laden working fluid to said inlet of said centrifuge such that the centrifugal force of the already spinning rotor creates a hollow central air core in said contaminant-laden working fluid allowing escape of air.

16. In a filtering system for filtering working fluid from a machine where filter capacity is too low for a permanent filter yet flow rate is too high for a centrifuge, a combination employing the flow rate capability of a filter with the storage capacity capability of a centrifuge, comprising a cleanable filter having a filter media element for filtering said working fluid, said cleanable filter having a first inlet receiving working fluid from said machine, said cleanable filter having a first outlet returning working fluid to said machine, said cleanable filter having a second inlet receiving a cleaning fluid from a source of cleaning fluid, said cleanable filter having a second outlet exhausting said cleaning fluid, said filter media element having a clean side communicating with said first outlet and said second inlet, said filter media element having a dirty side communicating with said first inlet and said second outlet, said cleanable filter having a first flowpath therethrough from said first inlet through said filter media element in one direction to said first outlet, said cleanable filter having a second flowpath therethrough from said second inlet through said filter media element

15 in the opposite direction to said second outlet, said first and second flowpaths having  
common but opposite direction portions through said filter media element, said  
cleanable filter having a filtering mode of operation with said second inlet closed and  
said second outlet closed and filtering fluid flow therethrough along said first flowpath,  
20 said cleanable filter having a backwash mode of operation with said second inlet open  
and said second outlet open and cleaning fluid flowing therethrough along said second  
flowpath and backwashing contaminant-laden working fluid from said dirty side of said  
filter media element to said second outlet, said centrifuge having an inlet connected to  
said second outlet of said cleanable filter, said centrifuge having a batch processing  
mode operative during said backwashing mode of said cleanable filter and receiving said  
25 contaminant-laden working fluid from said second outlet of said cleanable filter and  
separating and storing contaminant.

17. The invention according to claim 16 wherein said cleanable filter is a  
continuous flow filter in said filtering mode, and said centrifuge is a non-continuous  
flow batch processor having a rotor driven during said backwash mode of said cleanable  
filter and separating contaminant, said rotor being nondriven during said filtering mode  
5 of said cleanable filter.

18. The invention according to claim 16 comprising a plurality of said  
cleanable filters having respective said second outlets connected in parallel to said inlet  
of said centrifuge.

19. The invention according to claim 18 wherein said centrifuge has a  
plurality of batch processing modes operating serially sequentially, one mode for each  
of said cleanable filters.

20. A filtering system for filtering working fluid from a machine, said  
system combining a cleanable filter and a centrifuge and transferring a contaminant  
storage function from said cleanable filter to said centrifuge, said cleanable filter having  
a filter media element for filtering said working fluid, said cleanable filter having a first  
5 inlet receiving working fluid from said machine, said cleanable filter having a first outlet  
returning working fluid to said machine, said cleanable filter having a second inlet  
receiving a cleaning fluid from a source of cleaning fluid, said cleanable filter having a  
second outlet exhausting said cleaning fluid, said filter media element having a clean

side communicating with said first outlet and said second inlet, said filter media element  
 10 having a dirty side communicating with said first inlet and said second outlet, said  
 cleanable filter having a first flowpath therethrough from said first inlet through said  
 filter media element in one direction to said first outlet, said cleanable filter having a  
 second flowpath therethrough from said second inlet through said filter media element  
 in the opposite direction to said second outlet, said first and second flowpaths having  
 15 common but opposite direction portions through said filter media element, said  
 cleanable filter having a filtering mode of operation with said second inlet closed and  
 said second outlet closed and filtering fluid flow therethrough along said first flowpath,  
 said cleanable filter having a backwash mode of operation with said second inlet open  
 and said second outlet open and cleaning fluid flowing therethrough along said second  
 20 flowpath and backwashing contaminant-laden working fluid from said dirty side of said  
 filter media element to said second outlet, said centrifuge having an inlet connected to  
 said second outlet of said cleanable filter and receiving contaminant-laden working fluid  
 therefrom and separating and storing contaminant.

21. The invention according to claim 20 wherein said centrifuge  
 comprises a housing having a rotor mounted for rotation therein about an axis, said rotor  
 having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical  
 sidewall spaced radially outwardly of said inner cylindrical sidewall and defining an  
 annular space therebetween, said inner cylindrical sidewall having a transfer passage  
 5 therethrough providing communication of said hollow interior with said annular space,  
 said housing having an inlet for admitting contaminant-laden fluid to said hollow  
 interior of said inner cylindrical sidewall for passing through said transfer passage into  
 said annular space for centrifugal separation upon said rotation, said annular space  
 10 providing a storage container storing said contaminant.

22. The invention according to claim 21 wherein said rotor has a base  
 plate extending between said inner and outer cylindrical sidewalls, said rotor base plate  
 has a drain passage communicating with said annular space and effective upon stopping  
 of said rotation to drain fluid therefrom, and wherein said centrifuge is a batch processor  
 5 performing said separating function during rotation of said rotor and performing said  
 draining function after rotation of said rotor when said rotor is stopped.

23. The invention according to claim 22 comprising high-loft filter media in said annular space comprising a matrix of filter material of at least 75% void volume, said annular space providing said storage container storing said contaminant and retaining said contaminant in said high-loft filter media, said high-loft filter media retaining and storing said separated contaminant in said annular space, including after said rotation when said rotor is stopped, said high-loft filter media reducing re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor.

24. The invention according to claim 22 wherein said rotor outer cylindrical sidewall is removably separable from said base, and wherein said rotor further comprises a disposable liner shell capsule extending along and lining the interior of said outer cylindrical sidewall and accumulating and containing contaminant, such that said centrifuge may be serviced by removing said outer cylindrical sidewall and discarding said disposable liner shell capsule with contained contaminant therein and replacing same with another disposable liner shell capsule.

25. The invention according to claim 24 wherein said liner shell capsule further includes a base portion extending along and lining the interior of said rotor base plate, said drain passage being uncovered by said base portion of said liner shell capsule.

26. The invention according to claim 24 wherein said rotor outer cylindrical sidewall is a bell-shaped member, and said liner shell capsule is complementally bell-shaped along the interior thereof.

27. The invention according to claim 24 wherein said liner shell capsule defines said annular space therein, and comprising high-loft filter media in said liner shell capsule comprising a matrix of filter material of at least 75% void volume, said liner shell capsule providing said storage container storing said contaminant and retaining said contaminant in said high-loft filter media, said high-loft filter media retaining and storing said separated contaminant in said liner shell capsule, including after said rotation when said rotor is stopped, said high-loft filter media reducing re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor, said liner shell capsule with said high-loft filter media therein

10 being discarded upon servicing of said centrifuge, and replaced by another disposable liner shell capsule with fresh high-loft filter media therein.

28. The invention according to claim 20 wherein said centrifuge has a rotor centrifugally separating particulate contaminant from said working fluid by rotation of said rotor about an axis, said rotor having a turbine for causing rotation of said rotor in response to a pressurized gas jet motive force, said turbine having an inner  
5 ring on said rotor, a plurality of vanes extending radially outwardly to outer vane tips, and an outer ring at said outer vane tips, said outer ring blocking and containing deflected radially outward gas flow from said vanes and confining said deflected gas flow to the radial gap between said inner and outer rings.

29. The invention according to claim 28 wherein said rotor is mounted in a housing having first and second inlets, and an outlet, said first inlet being a fluid inlet admitting contaminant-laden fluid for said centrifugal separation of said contaminant upon rotation of said rotor, said second inlet being a gas inlet admitting said pressurized  
5 motive force gas to cause rotation of said rotor, said outlet being both a gas and fluid outlet exhausting both said fluid after said separation and said motive force gas after driving said rotor.

30. The invention according to claim 29 wherein said rotor has an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining a first annular space therebetween, said housing has a cylindrical sidewall spaced radially outwardly of said  
5 rotor outer cylindrical sidewall and defining a second annular space therebetween, said rotor inner cylindrical sidewall has a transfer passage therethrough providing communication of said hollow interior with said first annular space, said turbine is in said second annular space, said rotor has a base plate with a drain passage communicating with said first annular space, said housing has a base plate having a first  
10 port communicating with said hollow interior and providing said fluid inlet for admitting contaminant-laden fluid from said second outlet of said cleanable filter to said hollow interior of said rotor inner cylindrical sidewall for passing through said transfer passage into said first annular space for centrifugal separation upon said rotation, said housing base plate has a second port communicating with said drain passage and said second

15 annular space and providing said housing outlet exhausting said fluid from said first annular space through said drain passage and said gas from said second annular space.

31. The invention according to claim 20 wherein said centrifuge comprises a rotor mounted in a housing for rotation about an axis for centrifugally separating particulate contaminant from said contaminant-laden working fluid, said rotor having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical  
5 sidewall spaced radially outwardly of said inner cylindrical sidewall and defining a first annular space therebetween, said housing having a cylindrical sidewall spaced radially outwardly of said rotor outer cylindrical sidewall and defining a second annular space therebetween, said rotor inner cylindrical sidewall having a transfer passage therethrough providing communication of said hollow interior with said first annular space, said rotor having a base plate with a drain passage communicating with said first  
10 annular space, said rotor having a turbine for causing rotation of said rotor in response to a pressurized gas jet motive force, said housing having a base plate with first, second and third ports, said first port communicating with said hollow interior and being connected to said second outlet of said cleanable filter and providing a fluid inlet for admitting contaminant-laden fluid to said hollow interior of said rotor inner cylindrical  
15 sidewall for passing through said transfer passage into said first annular space for centrifugal separation, said second port communicating with said second annular space at said turbine for admitting pressurized gas for rotating said rotor, said third port communicating with said drain passage and said second annular space and exhausting  
20 both said fluid from said first annular space through said drain passage and said gas from said second annular space.

32. The invention according to claim 31 wherein said cleansing fluid is air, said contaminant-laden fluid contains both liquid and air, and said motive force pressurized gas is air.

33. A method for filtering working fluid from a machine comprising filtering said working fluid through a filter having a filter media element for filtering said working fluid, said filter having a first inlet receiving working fluid from said machine, said filter having a first outlet returning working fluid to said machine, said  
5 filter having a second inlet, supplying cleaning fluid to said second inlet from a source



of cleaning fluid, said filter having a second outlet, said filter media element having a clean side communicating with said first outlet and said second inlet, said filter media element having a dirty side communicating with said first inlet and said second outlet, said filter having a first flowpath therethrough from said first inlet through said filter media element in one direction to said first outlet, said filter having a second flowpath therethrough from said second inlet to said filter media element in the opposite direction to said second outlet, said first and second flowpaths having common but opposite direction portions through said filter media element, exhausting said cleaning fluid and contaminant-laden working fluid from said second outlet, and separating contaminant from said contaminant-laden working fluid with a contaminant separator.

34. The method according to claim 33 comprising also storing said contaminant in said contaminant separator and discharging said fluid from said contaminant separator after separation of contaminant.

35. The method according to claim 34 comprising circulating working fluid to said machine through a circulation system, and discharging working fluid from said contaminant separator to said circulation system.

36. The method according to claim 35 comprising providing a sump in said circulation system containing working fluid for said machine, and discharging working fluid from said contaminant separator to said sump.

37. The method according to claim 33 comprising providing said contaminant separator as a batch processor and operating said contaminant separator during said backwash mode of said filter such that said batch processor receives said contaminant-laden working fluid from said second outlet of said filter and separates and stores contaminant and passes working fluid.

38. The method according to claim 37 comprising providing said filter as a continuous flow filter in said filtering mode, and providing said batch processor as a non-continuous flow centrifuge, providing said centrifuge with a rotor and driving said rotor during said backwash mode of said filter to separate contaminants, and nondriving said rotor during said filtering mode of said filter.

39. The method according to claim 33 comprising providing said contaminant separator as a centrifuge having a rotor separating contaminant from working fluid and having a storage container storing said contaminant.

40. The method according to claim 39 comprising driving said rotor of said centrifuge by a motive force, and providing pressurized air as each of said motive force and said cleaning fluid.

41. The method according to claim 40 comprising providing a source of compressed air as said source of cleaning fluid, and supplying said pressurized air from said source of compressed air as both said motive force for said rotor and said cleaning fluid for said filter.

42. The method according to claim 41 comprising circulating working fluid to said machine through a circulation system, and discharging working fluid from said contaminant separator to said circulation system by gravity drain.

43. The method according to claim 41 comprising circulating working fluid to said machine through a circulation system, and discharging working fluid from said contaminant separator to said circulation system by a delayed charge of pressurized air from said source of compressed air pressurizing said centrifuge following said separation.

44. The method according to claim 39 comprising reducing fluid turbulence in said centrifuge during rotor speed gradients at start-up, trapping contaminant particles and reducing particle re-entrainment during rotor speed gradients.

45. The method according to claim 44 comprising reducing fluid turbulence in said centrifuge during rotor speed gradients at start-up, trapping contaminant particles and reducing particle re-entrainment during said rotor speed gradients by providing a second filter media element in said storage container.

46. The method according to claim 45 comprising providing said rotor with an annular chamber, and providing high-loft filter media comprising a matrix of filter material of at least 75% void volume as said second filter media element in said annular chamber in said rotor providing said storage container.

47. The method according to claim 41 comprising controlling the supply of pressurized air from said source of compressed air to said second inlet of said filter

and controlling the supply of pressurized air from said source of compressed air to said rotor of said centrifuge such that said rotor begins spinning prior to introduction of  
 5 contaminant-laden working fluid to said inlet of said centrifuge such that the centrifugal force of the already spinning rotor creates a hollow central air core in said contaminant-laden working fluid allowing escape of air.

48. A method for utilizing the flow rate capability of a filter and the storage capacity capability of a centrifuge in a combined filtering system for filtering working fluid from a machine where filter capacity is too low for a permanent filter yet flow rate is too high for a centrifuge, comprising in combination providing a cleanable  
 5 filter, providing a filter media element in said cleanable filter for filtering said working fluid, providing said cleanable filter with a first inlet receiving working fluid from a machine, providing said cleanable filter with a first outlet returning working fluid to said machine, providing said cleanable filter with a second inlet and supplying cleaning fluid to said second inlet from a source of cleaning fluid, providing said cleanable filter with a  
 10 second outlet exhausting said cleaning fluid, providing said filter media element with a clean side communicating with said first outlet and said second inlet, providing said filter media element with a dirty side communicating with a said first inlet and said second outlet, providing said cleanable filter with a first flowpath therethrough from said first inlet through said filter media element in one direction to said first outlet, providing said cleanable filter with a second flowpath therethrough from said second  
 15 inlet through said filter media element in the opposite direction to said second outlet, providing said first and second flowpaths having common but opposite direction portions through said filter media element, providing said cleanable filter with a filtering mode of operation with said second inlet closed and said second outlet closed and  
 20 filtering fluid flow therethrough along said first flowpath, providing said cleanable filter with a backwash mode of operation with said second inlet open and said second outlet open and said cleaning fluid flowing therethrough along said second flowpath and backwashing contaminant-laden working fluid from said dirty side of said filter media element to said second outlet, providing a centrifuge having an inlet and connecting said  
 25 inlet of said centrifuge to said second outlet of said cleanable filter, operating said centrifuge in a batch processing mode during said backwashing mode of said cleanable

filter and receiving said contaminant-laden working fluid from said second outlet of said cleanable filter and separating and storing contaminant.

49. The method according to claim 48 comprising providing said cleanable filter as a continuous flow filter in said filtering mode, and providing said centrifuge as a non-continuous flow batch processor having a rotor, driving said rotor during said backwash mode of said cleanable filter to separate contaminant, and nondriving said rotor during said filtering mode of said cleanable filter.

50. The method according to claim 48 comprising providing a plurality of said cleanable filters having respective said second outlets, and connecting said second outlets in parallel to said inlet of said centrifuge.

51. The method according to claim 50 comprising providing said centrifuge with a plurality of batch processing modes, and operating said batch processing modes serially sequentially, one mode for each of said cleanable filters.

52. A method of combining a cleanable filter and a centrifuge in a filtering system and transferring a contaminant storage function from said cleanable filter to said centrifuge, comprising providing a filter media element in said cleanable filter for filtering working fluid, providing said cleanable filter with a first inlet receiving working fluid from a machine, providing said cleanable filter with a first outlet returning working fluid to said machine, providing said cleanable filter with a second inlet and supplying cleaning fluid to said second inlet from a source of cleaning fluid, providing said cleanable filter with a second outlet exhausting said cleaning fluid, providing said filter media element with a clean side communicating with said first outlet and said second inlet, providing said filter media element with a dirty side communicating with a said first inlet and said second outlet, providing said cleanable filter with a first flowpath therethrough from said first inlet through said filter media element in one direction to said first outlet, providing said cleanable filter with a second flowpath therethrough from said second inlet through said filter media element in the opposite direction to said second outlet, providing said first and second flowpaths having common but opposite direction portions through said filter media element, providing said cleanable filter with a filtering mode of operation with said second inlet closed and said second outlet closed and filtering fluid flow therethrough along said first

flowpath, providing said cleanable filter with a backwash mode of operation with said  
 20 second inlet open and said second outlet open and said cleaning fluid flowing  
 therethrough along said second flowpath and backwashing contaminant-laden working  
 fluid from said dirty side of said filter media element to said second outlet, providing  
 said centrifuge with an inlet and connecting said inlet of said centrifuge to said second  
 25 outlet of said cleanable filter and discharging contaminant-laden working fluid from said  
 second outlet of said cleanable filter to said inlet of said centrifuge and separating and  
 storing contaminant in said centrifuge.

53. The method according to claim 52 comprising providing said  
 centrifuge with a housing having a rotor mounted for rotation therein about an axis,  
 providing said rotor with an inner cylindrical sidewall with a hollow interior, and an  
 5 outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall  
 and defining an annular space therebetween, providing said inner cylindrical sidewall  
 with a transfer passage therethrough providing communication of said hollow interior  
 with said annular space, providing said housing with an inlet for admitting contaminant-  
 laden fluid to said hollow interior of said inner cylindrical sidewall for passing through  
 said transfer passage into said annular space for centrifugal separation upon said  
 10 rotation, said annular space providing a storage container storing said contaminant,  
 providing said rotor with a base plate extending between said inner and outer cylindrical  
 sidewalls, providing said rotor base plate with a drain passage communicating with said  
 annular space and effective upon stopping of said rotation to drain fluid therefrom,  
 operating said centrifuge as a batch processor and performing said separating function  
 15 during rotation of said rotor and performing said draining function after rotation of said  
 rotor when said rotor is stopped.

54. The method according to claim 53 comprising providing high-loft  
 filter media in said annular space comprising a matrix of filter material of at least 75%  
 void volume, said annular space providing said storage container storing said  
 contaminant and retaining said contaminant in said high-loft filter media, said high-loft  
 5 filter media retaining and storing said separated contaminant in said annular space,  
 including after said rotation when said rotor is stopped, said high-loft filter media

reducing re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor.

55. The method according to claim 53 comprising providing said rotor outer cylindrical sidewall removably separable from said base plate, providing a disposable liner shell capsule extending along and lining the interior of said outer cylindrical sidewall and accumulating and containing contaminant, servicing said centrifuge by removing said outer cylindrical sidewall and then discarding said disposable liner shell capsule with contained contaminant therein and then replacing same with another disposable liner shell capsule.

56. The method according to claim 55 wherein said disposable liner shell capsule defines said annular space therein, and comprising providing high-loft filter media in said disposable liner shell capsule comprising a matrix of filter material of at least 75% void volume, said annular space providing said storage container storing said contaminant and retaining said contaminant in said high-loft filter media, said high-loft filter media retaining and storing said separated contaminant in said annular space, including after said rotation when said rotor is stopped, said high-loft filter media reducing re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor, and servicing said centrifuge by removing and discarding said disposable liner shell capsule with said high-loft filter media therein and replacing same by another disposable liner shell capsule with fresh high-loft filter media therein.

57. A centrifuge for separating particulate contaminant from a contaminant-laden fluid, comprising a housing having a rotor mounted for rotation therein about an axis, said rotor having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining an annular space therebetween, said inner cylindrical sidewall having a transfer passage therethrough providing communication of said hollow interior with said annular space, high-loft filter media in said annular space, said high-loft filter media comprising a matrix of filter material of at least 75% void volume, said housing having an inlet for admitting contaminant-laden fluid to said hollow interior of said inner cylindrical sidewall for passing through said transfer passage into

said annular space for centrifugal separation upon said rotation, said annular space providing a storage container storing said contaminant and retaining said contaminant in said high-loft filter media.

58. The invention according to claim 57 wherein said matrix of filter material of said high-loft filter media is selected from the group consisting of: fibrous material; polyester; foam, including reticulated foam; spun bonded web; wire mesh, including stainless steel; and sintered material, including porous composites.

59. The invention according to claim 58 wherein said rotor has a base plate extending between said inner and outer cylindrical sidewalls, said rotor base plate having a drain passage communicating with said annular space and effective upon stopping of said rotation to drain fluid therefrom.

60. The invention according to claim 59 wherein said centrifuge is a batch processor performing said separating function during rotation of said rotor, and performing said draining function after rotation of said rotor when said rotor is stopped, wherein said high-loft filter media retains and stores said separated contaminant in said annular space, including after said rotation when said rotor is stopped, and wherein said high-loft filter media reduces re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor.

61. The invention according to claim 59 wherein said rotor base plate has a configured surface facing said annular space and gravitationally guiding drainage of fluid therefrom to said drain passage upon said stopping of rotation.

62. The invention according to claim 61 wherein said configured surface has an upper-height outer portion adjacent said outer cylindrical sidewall, a lower pocket portion, and an intermediate-height inner portion adjacent said inner cylindrical sidewall, said configured surface being tapered radially inwardly and downwardly from said upper-height outer portion to said lower pocket portion and then upwardly to said intermediate-height inner portion, said upper-height outer portion having a height higher than said intermediate-height inner portion, said intermediate-height inner portion having a height greater than said lower pocket portion, said drain passage being at said intermediate-height inner portion, such that separated contaminant not retained by said

10 high-loft filter media is collected in said lower pocket portion, and fluid above said collected contaminant in said lower pocket portion drains to said drain passage.

63. The invention according to claim 62 wherein said rotor rotates about a central shaft, and wherein said drain passage is between said central shaft and said rotor base plate.

5 / 64. A centrifuge having a rotor centrifugally separating particulate contaminant from a contaminant-laden fluid by rotation of said rotor about an axis, a turbine for causing rotation of said rotor in response to a pressurized gas jet motive force, said turbine having an inner ring on said rotor, a plurality of vanes extending radially outwardly to outer vane tips, and an outer ring at said outer vane tips, said outer ring containing and blocking deflected radially outward gas flow from said vanes and confining said deflected gas flow to the radial gap between said inner and outer rings.

5 65. The invention according to claim 64 wherein said rotor is mounted in a housing having first and second inlets, and an outlet, said first inlet being a fluid inlet admitting contaminant-laden fluid for said centrifugal separation of said contaminant upon said rotation of said rotor, said second inlet being a gas inlet admitting said pressurized motive force gas to cause rotation of said rotor, said outlet being both a gas and fluid outlet exhausting both said fluid after said separation and said motive force gas.

5 66. The invention according to claim 65 wherein said rotor has an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining a first annular space therebetween, said housing has a cylindrical sidewall spaced radially outwardly of said rotor outer cylindrical sidewall and defining a second annular space therebetween, said rotor inner cylindrical sidewall has a transfer passage therethrough providing communication of said hollow interior with said first annular space, said turbine is in said second annular space, said rotor has a base plate with a drain passage communicating with said first annular space, said housing has a base plate with an inlet port communicating with said hollow interior of said inner cylindrical sidewall of said rotor and providing said fluid inlet for admitting contaminant-laden fluid to said hollow interior of said rotor inner cylindrical sidewall for passing through said transfer passage

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into said first annular space for centrifugal separation upon said rotation, said housing base plate having an outlet port communicating with said drain passage and said second  
 15 annular space and providing said outlet exhausting said fluid from said first annular space through said drain passage and said gas from said second annular space.

67. The invention according to claim 66 wherein said housing base plate has a second inlet port communicating with said turbine in said second annular space and providing said gas inlet.

68. A centrifuge having a rotor mounted in a housing for rotation about an axis for centrifugally separating particulate contaminant from a contaminant-laden fluid, said rotor having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining a first annular space therebetween, said housing having a cylindrical sidewall spaced radially outwardly of said rotor outer cylindrical sidewall and defining a second annular space therebetween, said rotor inner cylindrical sidewall having a transfer passage therethrough providing communication of said hollow interior with said first annular space, said rotor having a base plate extending between said inner and outer cylindrical sidewalls and having a drain passage communicating with said first annular space, said rotor having a turbine in said second annular space for causing rotation of said rotor, said housing having a base plate with first, second and third ports, said first port communicating with said hollow interior of said rotor inner cylindrical sidewall and providing an inlet for contaminant-laden fluid for admitting contaminant-laden fluid to  
 15 said hollow interior of said rotor inner cylindrical sidewall for passing through said transfer passage into said first annular space for centrifugal separation upon said rotation, said second port providing a pressurized gas jet motive force inlet communicating with said second annular space at said turbine for causing rotation of said rotor, said third port communicating with said drain passage and said second  
 20 annular space and providing an outlet exhausting both said fluid from said first annular space through said drain passage and said gas from said second annular space.

69. The invention according to claim 68 wherein said contaminant-laden fluid contains both liquid and gas.

70. The invention according to claim 69 wherein said gas of said motive force gas and said gas of said contaminant-laden fluid are the same.

71. A centrifuge for separating particulate contaminant from a contaminant-laden fluid, comprising a housing having a rotor mounted for rotation therein about an axis, said rotor having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining an annular space therebetween, said inner cylindrical sidewall having a transfer passage therethrough providing communication of said hollow interior with said annular space, said housing having an inlet for admitting contaminant-laden fluid to said hollow interior of said inner cylindrical sidewall for passing through said transfer passage into said annular space for centrifugal separation upon said rotation, said annular space providing a storage container storing said contaminant, said rotor having a base plate extending between said inner and outer cylindrical sidewalls, said base plate having a drain passage communicating with said annular space and effective upon stopping of said rotation to drain fluid therefrom, said outer cylindrical sidewall being removably separable from said base plate, said rotor further having a disposable liner shell capsule extending along and lining the interior of said outer cylindrical sidewall and accumulating and containing contaminant in said annular space, such that said centrifuge may be serviced by removing said outer cylindrical sidewall and then discarding said disposable liner shell capsule with contained contaminant therein and replacing same with another disposable liner shell capsule, said disposable liner shell capsule defining said annular space therein, high-loft filter media in said disposable liner shell capsule comprising a matrix of filter material of at least 75% void volume, said annular space providing said storage container storing said contaminant and retaining said contaminant in said high-loft filter media, said high-loft filter media retaining and storing said separated contaminant in said annular space, including after said rotation when said rotor is stopped, said high-loft filter media reducing re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor, said disposable liner shell capsule with said high-loft filter media therein being discarded upon servicing of said centrifuge, and replaced by another disposable liner shell capsule with fresh high-loft filter media therein.

72. The invention according to claim 71 wherein said liner shell capsule further includes a base portion extending along and lining the interior of said rotor base plate, said drain passage being uncovered by said base portion of said liner shell capsule.

73. The invention according to claim 71 wherein said outer cylindrical sidewall is a bell-shaped member, and said liner shell capsule is complementally bell-shaped along the interior thereof.

74. A centrifuge for separating particulate contaminant from contaminant-laden liquid in a gas stream, comprising a housing having a rotor mounted for rotation therein about an axis, said rotor having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining an annular space therebetween, said inner cylindrical sidewall having a transfer passage therethrough providing communication of said hollow interior with said annular space, said housing having an inlet for admitting said contaminant-laden liquid in said gas stream to said hollow interior of said inner cylindrical sidewall for passing through said transfer passage into said annular space for centrifugal separation upon said rotation, said rotor having a drain passage communicating with said annular space and effective upon stopping of said rotation to drain fluid therefrom, a standpipe circumscribing said inner cylindrical sidewall and dividing said annular space into an inner annular chamber between said standpipe and said inner cylindrical sidewall, and an outer annular chamber between said standpipe and said outer cylindrical sidewall, said standpipe having an upper end at said transfer passage, and having a lower end at said drain passage, such that during rotation, gas from said transfer passage is vented through said inner annular chamber to said drain passage, and contaminant-laden liquid from said transfer passage is centrifugally propelled into said outer annular chamber.

75. The invention according to claim 74 wherein said standpipe has an upper reach at said upper end at a level vertically below said transfer passage.

76. The invention according to claim 74 wherein said standpipe has one or more openings at said lower end draining fluid therethrough from said outer annular chamber to said drain passage upon said stopping of said rotation.

77. The invention according to claim 76 wherein said standpipe is perforated with a plurality of holes at said lower end covered with a ring of filter material.

78. The invention according to claim 76 wherein said rotor has a base plate extending between said inner and outer cylindrical walls, said rotor base plate has a configured surface facing said annular space and gravitationally guiding drainage of liquid therefrom to said drain passage upon said stopping of rotation, and wherein said standpipe at said lower end is mounted to said rotor base plate at said configured surface.

79. The invention according to claim 78 wherein said configured surface has an upper-height outer portion adjacent said outer cylindrical sidewall, a lower pocket portion, and an intermediate-height inner portion adjacent said inner cylindrical sidewall, said configured surface being tapered radially inwardly and downwardly from said upper-height outer portion to said lower pocket portion and then upwardly to said intermediate-height inner portion, said upper-height outer portion having a height higher than said intermediate-height inner portion, said intermediate-height inner portion having a height greater than said lower pocket portion, said drain passage being at said intermediate-height inner portion, such that separated contaminant is collected in said lower pocket portion, and liquid above said collected contaminant in said lower pocket portion drains to said drain passage.

80. The invention according to claim 79 wherein said rotor rotates about a central shaft, and wherein said drain passage is between said central shaft and said rotor base plate.

81. The invention according to claim 74 wherein said outer annular chamber has high-loft filter media therein comprising a matrix of filter material of at least 75% void volume, and wherein said inner annular chamber is left open without filter material therein to facilitate high volumetric flow of said gas therethrough to escape from said rotor quickly and with low pressure drop.

82. The invention according to claim 74 further comprising in combination a turbine for causing rotation of said rotor in response to a pressurized gas jet motive force, said turbine having an inner ring on said rotor, a plurality of vanes extending radially outwardly to outer vane tips, and an outer ring at said outer vane tips, said outer ring containing and blocking deflected radially outward gas flow from said

vanes and confining said deflected gas flow to the radial gap between said inner and outer rings.

83. The invention according to claim 82 wherein said gas of said pressurized gas jet motive force and said gas of said gas stream are the same.

84. A centrifuge having a rotor centrifugally separating particulate contaminant from contaminant-laden liquid in a gas stream by rotation of said rotor about an axis, a turbine for causing rotation of said rotor in response to a pressurized gas jet motive force, said rotor being mounted in a housing having first and second inlets, and an outlet, said first inlet being a liquid and gas inlet admitting said contaminant-laden liquid in said gas stream, said second inlet being a gas inlet admitting said pressurized motive force gas to cause rotation of said rotor, said outlet being a gas and fluid outlet exhausting said liquid after said separation and said gas stream and said motive force gas.

85. The invention according to claim 84 wherein said rotor has an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining a first annular space therebetween, said housing has a cylindrical sidewall spaced radially outwardly of said rotor outer cylindrical sidewall and defining a second annular space therebetween, said rotor inner cylindrical sidewall has a transfer passage therethrough providing communication of said hollow interior with said first annular space, said turbine is in said second annular space, said rotor has a base plate with a drain passage communicating with said first annular space, said housing has a base plate with an inlet port communicating with said hollow interior of said inner cylindrical sidewall of said rotor and providing said first inlet for admitting said contaminant-laden liquid in said gas stream to said hollow interior of said rotor inner cylindrical sidewall for passing through said transfer passage into said first annular space for centrifugal separation upon said rotation, said housing base plate having an outlet port communicating with said drain passage and said second annular space and providing said outlet exhausting said liquid from said first annular space through said drain passage and exhausting said gas stream from said first annular space through said drain passage and exhausting said gas from said second annular space.

86. The invention according to claim 85 comprising a standpipe circumscribing said inner cylindrical sidewall and dividing said first annular space into

an inner annular chamber between said standpipe and said rotor inner cylindrical sidewall, and an outer annular chamber between said standpipe and said rotor outer cylindrical sidewall, said standpipe having an upper end at said transfer passage, and having a lower end at said drain passage, such that during rotation, gas from said gas stream from said transfer passage is vented through said inner annular chamber to said drain passage, and contaminant-laden liquid from said transfer passage is centrifugally propelled into said outer annular chamber.

87. The invention according to claim 86 wherein said outer annular chamber has high-loft filter media therein comprising a matrix of filter material of at least 75% void volume, and wherein said inner annular chamber and said second annular space are left open without filter material therein.

88. A filtering system for filtering working fluid from a machine, said system combining a cleanable filter and a centrifuge and transferring a contaminant storage function from said cleanable filter to said centrifuge, said cleanable filter having a filter media element for filtering said working fluid, said cleanable filter having a first inlet receiving working fluid from said machine, said cleanable filter having a first outlet returning working fluid to said machine, said cleanable filter having a second inlet receiving a cleaning fluid from a source of cleaning fluid, said cleanable filter having a second outlet exhausting said cleaning fluid, said filter media element having a clean side communicating with said first outlet and said second inlet, said filter media element having a dirty side communicating with said first inlet and said second outlet, said cleanable-filter having a first flowpath therethrough from said first inlet through said filter media element in one direction to said first outlet, said cleanable filter having a second flowpath therethrough from said second inlet through said filter media element in the opposite direction to said second outlet, said first and second flowpaths having common but opposite direction portions through said filter media element, said cleanable filter having a filtering mode of operation with said second inlet closed and said second outlet closed and filtering fluid flow therethrough along said first flowpath, said cleanable filter having a backwash mode of operation with said second inlet open and said second outlet open and cleaning fluid flowing therethrough along said second flowpath and backwashing contaminant-laden working fluid from said dirty side of said filter media element to said second outlet, said centrifuge having an inlet connected to said second outlet of said cleanable filter and receiving contaminant-laden working fluid -

therefrom and separating and storing contaminant, said centrifuge comprising a housing having a rotor mounted for rotation therein about an axis, said rotor having an inner cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced radially outwardly of said inner cylindrical sidewall and defining an annular space therebetween, said inner cylindrical sidewall having a transfer passage therethrough providing communication of said hollow interior with said annular space, said housing having an inlet for admitting contaminant-laden fluid to said hollow interior of said inner cylindrical sidewall for passing through said transfer passage into said annular space for centrifugal separation upon said rotation, said annular space providing a storage container storing said contaminant, a standpipe circumscribing said inner cylindrical sidewall and dividing said annular space into an inner annular chamber between said standpipe and said inner cylindrical sidewall, and an outer annular chamber between said standpipe and said outer cylindrical sidewall.

89. The invention according to claim 88 wherein said rotor has a base plate extending between said inner and outer cylindrical sidewalls, said rotor base plate has a drain passage communicating with said annular space and effective upon stopping of said rotation to drain fluid therefrom, said standpipe has an upper end at said transfer passage, and has a lower end at said drain passage, and wherein said contaminant-laden fluid comprises contaminant-laden liquid in a gas stream, and such that during rotation, gas in said gas stream from said transfer passage is vented through said inner annular chamber to said drain passage, and contaminant-laden liquid from said transfer passage is centrifugally propelled into said outer annular chamber.

90. The invention according to claim 89 comprising high-loft filter media in said outer annular chamber comprising a matrix of filter material of at least 75% void volume, said outer annular chamber providing a storage container storing said contaminant and retaining said contaminant in said high-loft filter media, said high-loft filter media retaining and storing said separated contaminant in said outer annular chamber, including after said rotation when said rotor is stopped, said high-loft filter media reducing re-entrainment of said separated contaminant during start-up at the beginning of the next rotation of said rotor.

91. The invention according to claim 89 wherein said rotor outer cylindrical sidewall is removably separable from said base, and wherein said rotor further comprises a disposable liner shell capsule extending along and lining the interior

of said outer cylindrical sidewall and accumulating and containing contaminant, such  
 5 that said centrifuge may be serviced by removing said outer cylindrical sidewall and  
 discarding said disposable liner shell capsule with contained contaminant therein and  
 replacing same with another disposable liner shell capsule.

92. A method of combining a cleanable filter and a centrifuge in a  
 filtering system and transferring a contaminant storage function from said cleanable  
 filter to said centrifuge, comprising providing a filter media element in said cleanable  
 filter for filtering working fluid, providing said cleanable filter with a first inlet  
 5 receiving working fluid from a machine, providing said cleanable filter with a first outlet  
 returning working fluid to said machine, providing said cleanable filter with a second  
 inlet and supplying cleaning fluid to said second inlet from a source of cleaning fluid,  
 providing said cleanable filter with a second outlet exhausting said cleaning fluid,  
 providing said filter media element with a clean side communicating with said first  
 10 outlet and said second inlet, providing said filter media element with a dirty side  
 communicating with a said first inlet and said second outlet, providing said cleanable  
 filter with a first flowpath therethrough from said first inlet through said filter media  
 element in one direction to said first outlet, providing said cleanable filter with a second  
 flowpath therethrough from said second inlet through said filter media element in the  
 15 opposite direction to said second outlet, providing said first and second flowpaths  
 having common but opposite direction portions through said filter media element,  
 providing said cleanable filter with a filtering mode of operation with said second inlet  
 closed and said second outlet closed and filtering fluid flow therethrough along said first  
 flowpath, providing said cleanable filter with a backwash mode of operation with said  
 20 second inlet open and said second outlet open and said cleaning fluid flowing  
 therethrough along said second flowpath and backwashing contaminant-laden working  
 fluid from said dirty side of said filter media element to said second outlet, providing  
 said centrifuge with an inlet and connecting said inlet of said centrifuge to said second  
 outlet of said cleanable filter and discharging contaminant-laden working fluid from said  
 25 second outlet of said cleanable filter to said inlet of said centrifuge and separating and  
 storing contaminant in said centrifuge, providing said centrifuge with a housing having a  
 rotor mounted for rotation therein about an axis, providing said rotor with an inner  
 cylindrical sidewall with a hollow interior, and an outer cylindrical sidewall spaced  
 radially outwardly of said inner cylindrical sidewall and defining an annular space



30 therebetween, providing said inner cylindrical sidewall with a transfer passage  
 therethrough providing communication of said hollow interior with said annular space,  
 providing said housing with an inlet for admitting contaminant-laden fluid to said  
 hollow interior of said inner cylindrical sidewall for passing through said transfer  
 passage into said annular space for centrifugal separation upon said rotation, said  
 35 annular space providing a storage container storing said contaminant, providing said  
 rotor with a base plate extending between said inner and outer cylindrical sidewalls,  
 providing said rotor base plate with a drain passage communicating with said annular  
 space and effective upon stopping of said rotation to drain fluid therefrom, operating  
 said centrifuge as a batch processor and performing said separating function during  
 40 rotation of said rotor and performing said draining function after rotation of said rotor  
 when said rotor is stopped, providing a standpipe circumscribing said inner cylindrical  
 sidewall and dividing said annular space into an inner annular chamber between said  
 standpipe and said inner cylindrical sidewall, and an outer annular chamber between  
 said standpipe and said outer cylindrical sidewall, providing said standpipe with an  
 45 upper end at said transfer passage, providing said standpipe with a lower end having one  
 or more openings at said drain passage, said fluid containing contaminant-laden liquid in  
 a gas stream, and during rotation, venting gas from said transfer passage through said  
 inner annular chamber to said drain passage, and centrifugally propelling contaminant-  
 laden liquid from said transfer passage into said outer annular chamber, and upon  
 50 stopping of said rotation, draining liquid from said outer annular chamber through said  
 one or more openings at said lower end of said standpipe to said drain passage.

93. The method according to claim 92 comprising providing high-loft  
 filter media in said outer annular chamber comprising a matrix of filter material of at  
 least 75% void volume, said outer annular chamber providing said storage container  
 storing said contaminant and retaining said contaminant in said high-loft filter media,  
 5 said high-loft filter media retaining and storing said separated contaminant in said outer  
 annular chamber, including after said rotation when said rotor is stopped, said high-loft  
 filter media reducing re-entrainment of said separated contaminant during start-up at the  
 beginning of the next rotation of said rotor.